حصاد مؤتمر

الماء والحياة في شبه الجزيرة العربية





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Typology of Irrigation Systems in Ancient Yemen in the Light of the Epigraphic Evidence

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Abstract:

The significance of water in the Arabian Peninsula and in particular Yemen can scarcely be overstated. Ancient South Arabians developed techniques of water harvesting and what was to become Yemen had a long tradition of irrigation involving comprehensive hydraulic structures such as the ancient dam in Ma'rib at the fringes of the desert of the Empty Quarter. It also used rainwater harvesting techniques in the mountainous highlands. The purpose of this paper is to provide an overview of the different types of irrigation systems in ancient Yemen in context with the epigraphic evidence.

Keywords: ancient Yemen, South Arabia, ancient water technology, water systems, water rights, Ma'rib, flood irrigation

Introduction

There are hundreds of ancient water systems throughout Yemen, dating from ca. the 4th millennium BCE to the 20th century (Brunner & Kohler 1997: 171-198; Kühn et al. 2010: 1305-1310; Maktari 1971). These irrigation practices reached their rank during the period of the South Arabian kingdoms (Fig. 1) from beginning of the first millennium BCE to the eve of Islam (Hehmeyer & Schmidt 1991; Francaviglia 2002: 111-144; Wilkinson 2003: 45–70; Harrower 2008). This can be seen in the Great dam of Ma'rib (Brunner 2004: 405-413).

Almost every Wadi contains the ruins of dams or diversion walls (Wilkinson 2003: 186-189, Charbonnier & Schiettecatte 2013: 69-89) [1]. They range in size from the great dam of Ma'rib to long perennial watercourses beginning at springs (Brunner & Kohler 1997: 171-198).

Archaeological and geomorphological investigations of irrigation systems in ancient Yemen have increased during the last four decades. This results from archaeological and epigraphic discoveries as well as to the geomorphological investigations accomplished by native and international archaeological missions in Yemen. Dozens of South Arabian inscriptions, especially Sabaic ones, document the construction of irrigation systems and their socio-economic role in the society have been discovered [2].

The topics of this study are as follows:
I. Sources for the study of irrigation systems
II. Towards a typology of irrigation systems in ancient Yemen
III. Water rights and management

I. Sources for the study of irrigation systems

Among the thousands of South Arabian inscriptions (Sabaic, Qatabanic, Minaic, and Hadramitic), in particular ca. 270 texts document the history of irrigation systems [3]. Some of them inform us about water resource management and water management. Several texts recount the construction of dams or irrigation channels. Other texts inform us about dams or the restoration of large dams, especially the restoration of the great

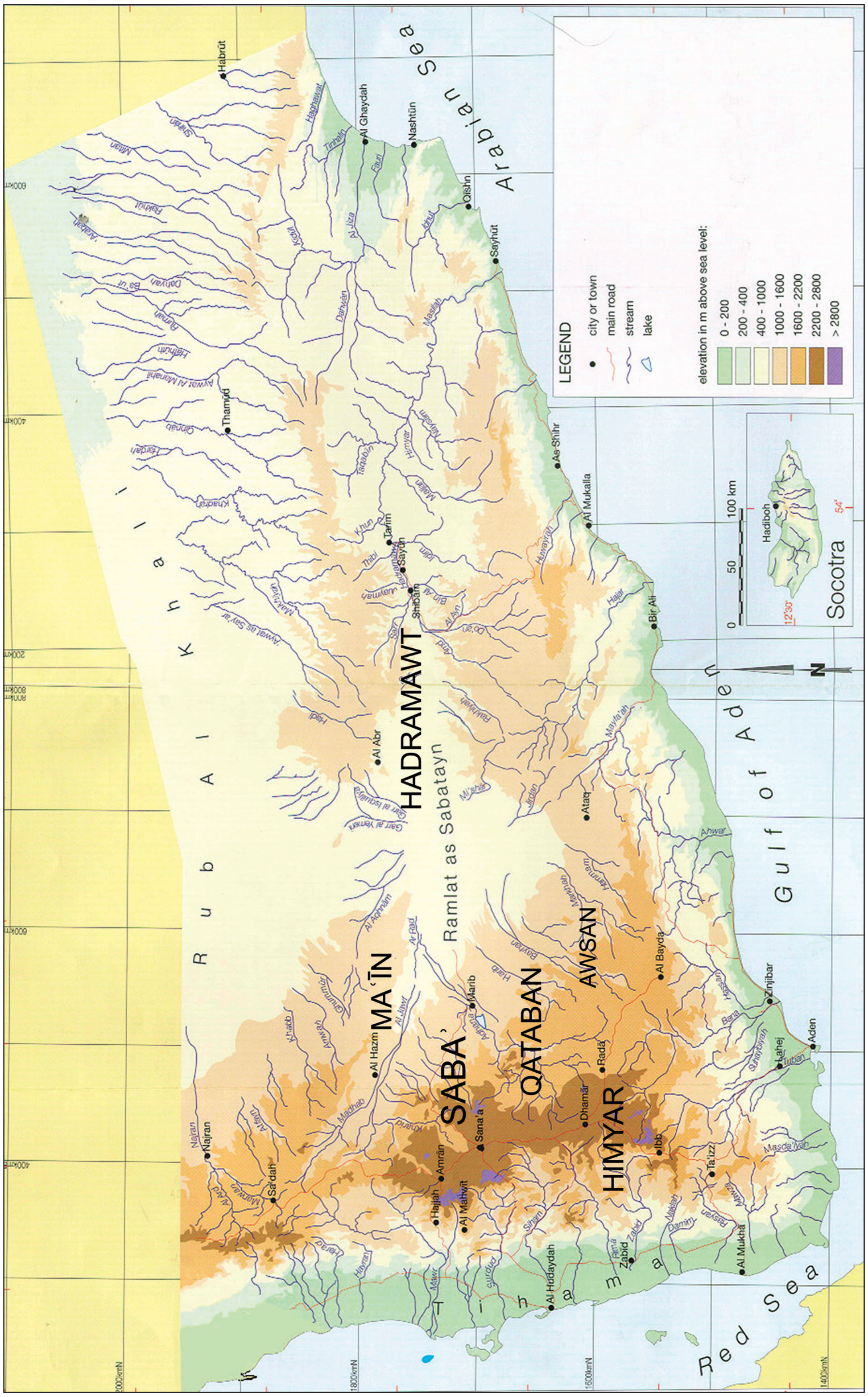


Figure 1: Map of Yemen (http://www.yostours.com.ye/map_yemen2.jpg, modified, M. Maraqten)

dam of Ma'rib (CIH 540, 541, Müller 2010: 68-74, 110-117; Jamme 1955; Nebes 2004: 221-230).

An overview of the irrigation systems in ancient South Arabia in particular in Saba' (Fig. 2) have been made by several scholars (Wolfrum D. & Wolfrum Ch. 2001: 80-102; Brunner & Kohler 1997: 171-198; Francaviglia 2002: 111-144; Gerlach 2012: 187-198).

II. Towards a typology of irrigation systems in ancient Yemen

Rain fed watercourses or Wadis channel the hydrographic resources of Yemen. Two major categories of irrigation systems have been developed according to the water resources, namely the flood irrigation systems including runoff rain harvesting and ground water irrigation systems (Eger 1988). Most prominently attested term in Sabaic texts for an "irrigation system" is ms¹qt (MṢM 168, Ghul Ḥūṯ 1/1; Ghul Ḥūṯ 2/2; RES 4626/2, Sabaic); see also the term mbrʾ "irrigation work" (BaBa al-Ḥadd 8/3 Sabaic; ʿIryāb 1, Qatabanic) and mʿs¹ʾ "irrigation work" (Ma'rib 53/2).

A water system is always characterized by a specific combination of three components [4]:

1. Water source: Seasonal flood water (sayl) was the most important source for irrigation and runoff rain water harvesting (Eger 1988). Further



Figure 2: *Map of* Saba' *(courtesy H. David-Cuny)*

the groundwater, springs (ʿyn), spring flow such as the perennial water flow (ġyl) and spring wells (sg. bʾr) were also an important source.

2. Hydraulic construction: Floodwater harvesting was managed by the construction of great dams (sg. ʿrm, Arabic ʿarim) such as the great dam of Ma'rib (ʿrmn mrb); further diversion dams and dykes are known (mʾḫḏ, ʿḍd, mns²ʾ, etc.). There are also the storage facilities such reservoirs or tanks (sg. brkt, krf, mʾgl,ʾhl). The technique method used to harvest runoff rain water harvesting was by the layout of irrigated terraces (grbt, ʿs²q).
3. Distribution and control of water: The conveyance or deflection devices are expressed by many South Arabian terms relating to canals. There are major distributer canals (fnwt, ḥrt), and different types of conduits (mʾtw "inlet/outlet channel", s²rg "watercourse" etc., Beeston et al. 1982: 134). Cut in the rock canals (nqb), and tunnels (mqṣʿ, Beeston et al. 1982: 109), e.g. Baynūn (see below) as well as under earth canals (qanāts) are also known (see below).

According to the water sources, two major irrigation systems are to be distinguished: A. Runoff irrigation systems and water harvesting techniques and B. ground water irrigation systems.

A. Runoff irrigation systems and water harvesting techniques

Runoff irrigation is the oldest form of irrigation, which has been practiced in semi-arid and arid areas for millennia in the ancient world. Ancient civilizations in arid and semi-arid regions developed very effective systems for harvesting rain water in many parts of the world. Although, it is very difficult to date the historic bench terraces in Yemen, terrace fields might have been existed already in the 3rd millennium BCE (Kopp 1981: 107f; Eger 1988; Wilkinson 2003: 184-195).

Floodwater (South Arabic s¹yl, Arabic sayl) harvesting systems are characterized by collecting runoff water collected from a large catchment area. Many different types of flood irrigation systems have been used to harvest the flash floods in ancient Yemen (Eger 1988; Wilkinson 2003: 184-195; Serjeant 1964: 33-76; Maktari 1971: 49-66).

Several terms are attested in the inscriptions in the meaning of irrigated Wadi such as s¹r (pl. ʾs¹rr) "irrigated wadi, oasis" (MB 2004 I-144, Sabaic), ḏhb (pl. ʾḏhb) "irrigated wadi" (Ja 541, Sabaic), mwdyn "irrigated wadi" (Ja 2362, Qatabanic, ATHS 52, from al-Sawdāʾ/Naššān). Good data are available in the inscriptions relating to wadi-bed irrigation systems (e.g. DhM 201; Ghul Ḥūṯ 2; Ja 627/7; Ja 628/23, Sabaic). Flood irrigation systems might be summarized as follows:

1. ʿRM-Dams

The majority of the irrigation dams of ancient Yemen belong to type of flood water technology. Such were not primarily storage dams, but rather diversion dams which served to raise the level of the flood water to the level of the fields to irrigate them and among the well-known Ma'rib dam (Brunner 2000; Gerlach 2012: 187-198).

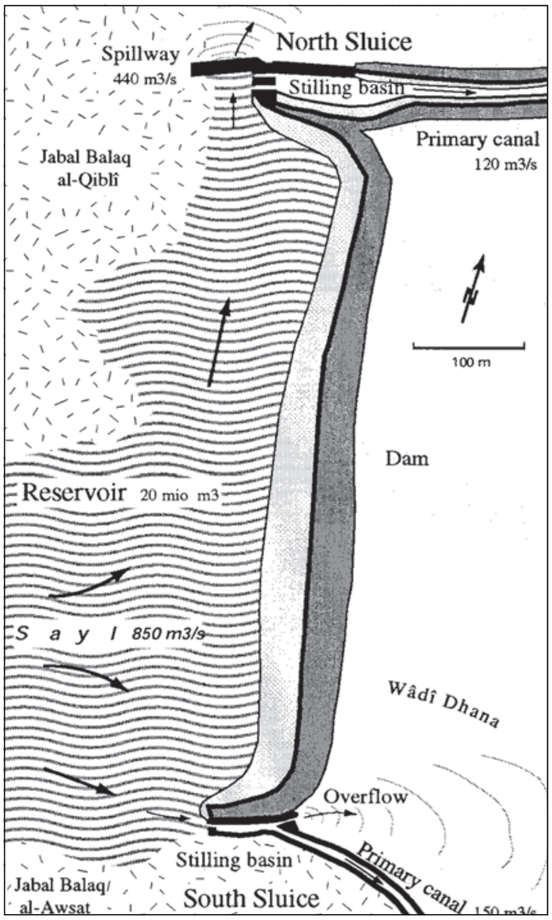


Figure 3: *Sketch of the dam of* Ma'rib *(after U. Brunner 2000)*



Figure 4: *The great dam of Ma'rib, south and north sluice (Photo: M. Maraqten)*

The prominent type of this category is the ʿRM-dam. The term ʿrm is primarily applies to the great Ma’rib dam (ʿrmn mrb). Arabic lexicons interprets the term ʿarim as “a dam (sadd) that is raised across a valley, or torrent-bed” or as Arabic musannāt “strongly-constructed barrage” (Lane V, 2025). However, this term also designates small diversion dam in the highland of Yemen (e.g. Kh-Mārīya 3, Noman 2013: 52). Today the term ʿarīm “barrage” still is used in traditional irrigation in Yemen (Piamenta 1991: 324; al-Iryānī 1996: 620f.; al-Akwaʿ 2001).

The great Ma’rib dam: The most famous irrigation work in Yemen is the ʿrmn mʾrb “the great Ma’rib dam” (Fig. 3) in Wadi Dhanah (Brunner 2000: 167-182; 2004: 405-413). It was constructed at the narrowest point along the bed of Wadi Dhanah between the Jabal Balaq al-Awsaṭ and the Jabal Balaq al-Qibli (Brunner 2012: 195-195).

It consists of an earth dam of ca. 680 m in length spanning the wadi, ca. 18 m in height, two sluice system in the north and the south (fig. 3, 4) and water distributes and canal networks which reached the fields to appoint of more than 20 km (Brunner 2012: 195-195).

The great Ma’rib dam is generally regarded as a sayl-irrigation system and depending on the large-size catchment area of rain of Wadi Dhanah, which has been estimated to comprise more than 10.000 km2 (Brunner 2004: 405-413). In order to use the sayl-water for irrigation it was diverted from wadi-bed onto the fields where it was distributed via the canal network. Thus irrigation water was available only during the sayl period (Brunner 2004: 405-413).

This irrigation system served to irrigate more than 9,600 hectares (Brunner 1983: 2000: 167-182). The irrigated area is divided into two oasis, the northern oasis is called ʾbyn and the southern larger one is named ys^{1}rn (Hehmeyer & Schmidt 1991; Wilkinson 2003: 161-164). These are the ǧannatayn “the two gardens” mentioned in the Koran (34: 15). The geomorphological investigations (Brunner 1983) and the archaeological investigations (Vogt 2004: 383-394) as well as the epigraphic evidence reveal a complex water distribution system (Darles et al. 2013: 7-68; Robin 2013: 247-287).

Already in the 4th millennium BCE prehistoric irrigation systems existed in the oasis of Ma’rib. The history of the great dam goes back to at least the beginning of the 2rd millennium BCE. Irrigation systems of the oasis of Ma’rib have been intensively investigated by the DAI (Brunner 1983; Hehmeyer & Schmidt 1991; Brunner 2000: 167-182; Vogt 2004: 383-394).

Archaeological investigations reveal for the Ma’rib dam different architectural phases of the construction. Phase A (Herberg 1986: 33-47) and phase B belonged possibly to the 2nd millennium (Brunner 1983; Hehmeyer & Schmidt 1991; Brunner 2000: 167-182; Gerlach 2012: 187-198).

In the 8th-6th centuries BCE the great dam took on the shape as we know it today (Fig. 4), the north and the south sluices were constructed (CIH 622a, CIH 622, CIH 623, ca. 6th century BCE) [5].

Epigraphic discoveries of the AFSM shed data about irrigation in the Ma’rib oasis and in particular about the great dam (e.g. MB 2004 I-151, MB 2004 I-156, MB 2004 I-211, MB 2005 I-3) [6].

The construction of an irrigation system in Wadi Dhanah

An Early Sabaic (fig. 5) 4-line inscription the 8th century BCE engraved on the south side of Jabal al-Balaq al-Qiblī reports about the construction of the earliest irrigation system in Wadi Dhanah in the approximately in the same place of the great dam (DAI Ǧabal Balaq al–Qiblī 1 = Maraqten-Marib 4; Nebes 2010: 184, 2015: 96-98; Maraqten 2013: 213).

Transcription

1. s^{2}yṭm / bn / ys^{2}r / wʾnbʿ / kbr/ mydʿm
2. mwd / ykrbmlk / wyṯʿʾmr / bny / hr
3. dʿ / wʿglmtn / wbrʾ / ʿs^{1}ntn / wʿs^{1}n
4. ʾnwt / bn / ḏhbm /

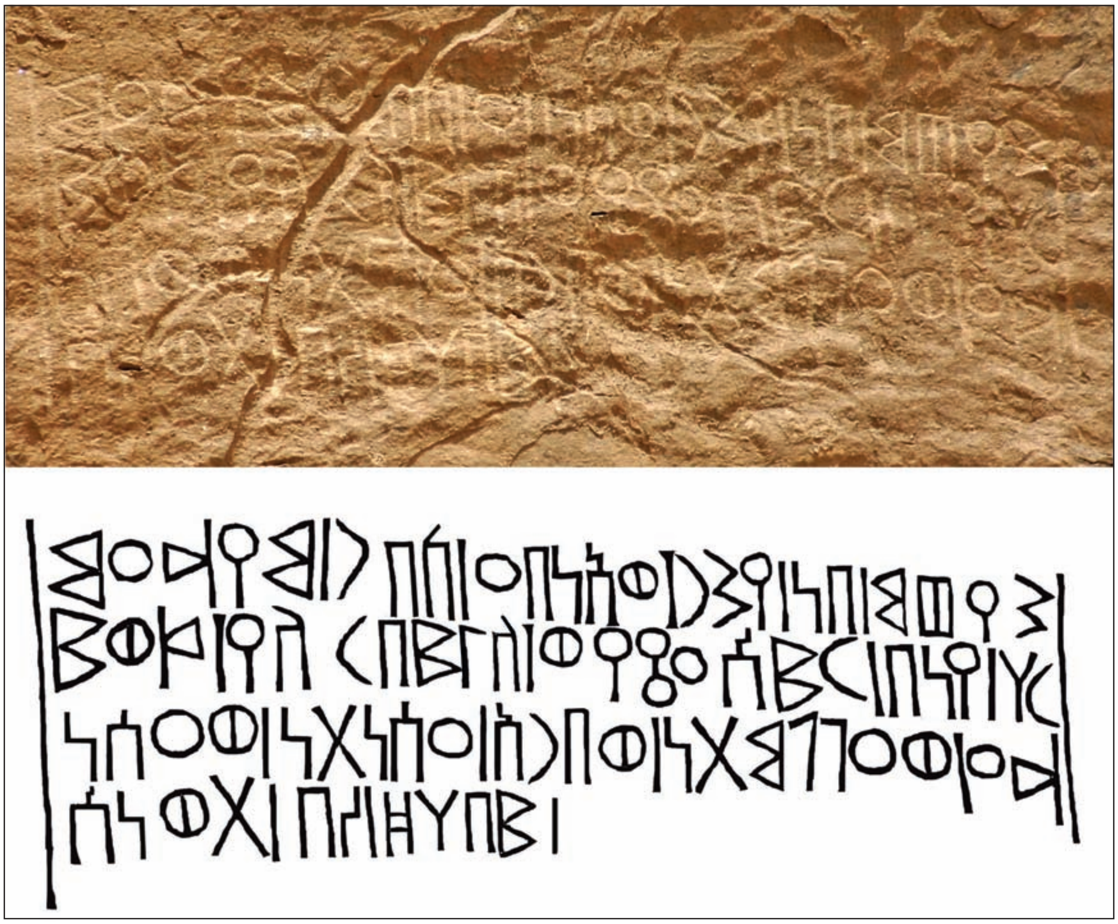


Figure 5: *Early Sabaic rock inscription from Jabal Balaq al-Qiblī, Ma'rib (photo and facsimile M. Maraqten)*

Translation

1. Šayyāṭum son of Yašār and Anbaʿ, the Kabīr of Maydaʿum, the
2. administrator (friend) of (the Mukarrib) Yakrubmalik and (the Mukarrib) Yaṯaʿʾamar has constructed
3. (the dam) Hardaʿ and the diversion mole, and constructed the foundation and cut in the rock (the dam)
4. Anwat in order to control the flood of the wadi.

One of the most important tasks of the Sabaean ruler was to maintain the Ma'rib dam and to repair damage which occurred continually. The first recorded break occurred about the middle of the 4th century CE (Ja 671) by the Thảrān Yuhanʿim and in the time of Shuraḥbiʾīl Yaʿfur ca. 450 CE (CIH 540; Kropp 1994: 122-131; Gajda 2009: 58-60) and ca. 540 CE in the time of Abyssinian king Abraha (CIH 541; Ja 547+Ja 546+Ja 544+Ja 545; Jamme 1955: 265-281; Sima 2002: 126-132; Nebes 2004: 221-230; Müller 2010).

Sabaic records inform us about damages to the dam and efforts of the kings to reconstruct it (Brunner 2000: 167-182; Vogt 2004: 383-394; Darles et al. 2013: 7-68; Robin 2013: 247-287). However, the last break and final collapse of the great dam system took place at the end of the 6th or the beginning of the 7th century CE, which Classical Arabic sources describe as a catastrophe. This also is mentioned in the Koran as the end of the kingdom of Saba' (Brunner 2000: 167-182). Arabic traditions maintain that many tribes left Yemen after the breaking of the dam and that this event led to the end of the South Arabian culture. It can be assumed that part of the society did in fact lose its economic base after the dam broke.

2. MʾḪḎ-Dam

The term mʾḫḏ refers primarily to a "control dyke, barrage" and occurs in the meaning of "basin, reservoir" (Beeston et al. 1982: 3). This type of deflector dam is one of the most attested types in the inscriptions. It was used widely in oasis and in the Yemenite highlands.

The construction and the ownership of a Ma'ḫaḏ-Dam by the Banū Maqār in the South oasis, Ma'rib

This control dyke (9.60 x 7.50 m) came to light during the building of a new house by local people and a sondage of the DAI in Manīn al-Ḥadad in the southern oasis of Ma'rib (DAI 1998-Wasserbau 1, fig. 6; Maraqten 2013: 218f.). The inscription (260 x 30 cm, fig. 7) that documents this irrigation system is engraved on the façade of this barrage dam. It dates to the period of the Sabaean king Karibʾīl Bayn (ca. 105-90 BCE) [7].

Transcription

1. ʿmkrb / wḥywm / wbnhmy / nbṭʾl / bnw / mqrm / ʿs¹ʾw / wbny / whwṯr / ws²qr / whḥdṯ / wqny / wbrl / mʾḫḏhmw / yṯʿn / mʾḫḏ / nḫlhmw
2. mrymn / wʾnḫl / ʾtmw / bʿmhw / ʾnḫl / qnyw / bnw / mqrm / wʾl / ʾs¹/ s¹ʾl / bny / mqrm / bmʾḫḏhmw / yṯʿn / bʿṯtr / wb / hwbs¹ / wb / ʾlmqh / wb
3. ḏt / ḥmym / wb / ḏt / bʿdnm / wb / mrʾyhmw / krbʾl / byn / mlk / s¹bʾ / wʾḫhw / ʾls²rḥ / bny / s¹mhʿly / ḏrḥ / wb 7 s²ʿbhmw / fys²n

Translation

1. ʿAmmīkarib and Ḥaywum and their son Nabaṭʾīl of the clan Banū Maqārum have constructed, built, laid the foundations, completed, established and acquired as well as gained possession of their Ma'ḫaḏ-dam Yaṯʿān, the Maḫaḏ-dam of their palm grove
2. Maryamān, in addition to the palm groves that Banū Maqārum have obtained and acquired with it. Let no one raise a claim to Banī Maqārum concerning their Ma'ḫaḏ-dam Yaṯʿān. By ʿAṯtar, by Hawbas, by Almaqah and
3. and by Ḏāt-Ḥamīm, and by Ḏāt-Baʿdānum, and by their both lords, Karibʾīl Bayn, king of Saba' and his brother ʾĪl-šaraḥ sons of Sumhuʿalī Ḏarīḥ and by their tribe Fayšān



Figure 6: *Ma'ḫaḏ-dam in the south oasis, Ma'rib (Photo: M. Maraqten)*

3 ḤRT-irrigation system

The term ḥrt “irrigation canal, major canal” is one of the most attested in Sabaic in relation with irrigation systems. It is also attested in the meaning of “water system” (RES 4907/5).

A report on the construction of ḤRT-irrigation system in Wadi al-Jawf

The text reports about a whole system of irrigation (MṢM 168, fig. 8). It consists of a major irrigation channel (ḥrt), canalization system (mḥmt) and irrigation system (ms¹qt). This ḥrt-irrigation system was used for the irrigation of palm groves and belonged to vassals of the kings of Saba’. This inscription (65 x 56 x 7 cm.) is stored in the University Military Museum, Ṣanʿāʾ. It has been discovered in al-Jawf and to be dated back to the ca. 1st century BCE to 1st century CE (see CSAI).

Transcription

1. ʾws¹ʿṯt / wʾws¹m / wʾlwhb / wbnhm
2. w / bnw / ḏḫyrhmw / ʾdm / mlkn / hwṯr
3. w / wbrʾ / ws²qr / ḥrthmw / tġl / m
4. ḥmtm / wms¹qtm / lʾnḫlhmw / whry
5. hmw / bḏmwhbm / bʿṯtr / wwdm / wʾ
6. rnydʿ / wb / ʾmrʾhmw / ʾmlk / s¹bʾ

Translation

1. Awsʿaṯt and Awsum and ʾĪlwahab and their sons,
2. of the clan Ḏū-Ḫayrahumū, vassals of the king, laid the foundations,
3. constructed and completed their major irrigation canal Taġul, a
4. canalization system and an irrigation system of their palm groves and their
5. two cisterns in Ḏū-Mawhabum. By ʿAṯtar, Waddm and
6. Aranyadaʿ, and by their lords the kings of Sabả.

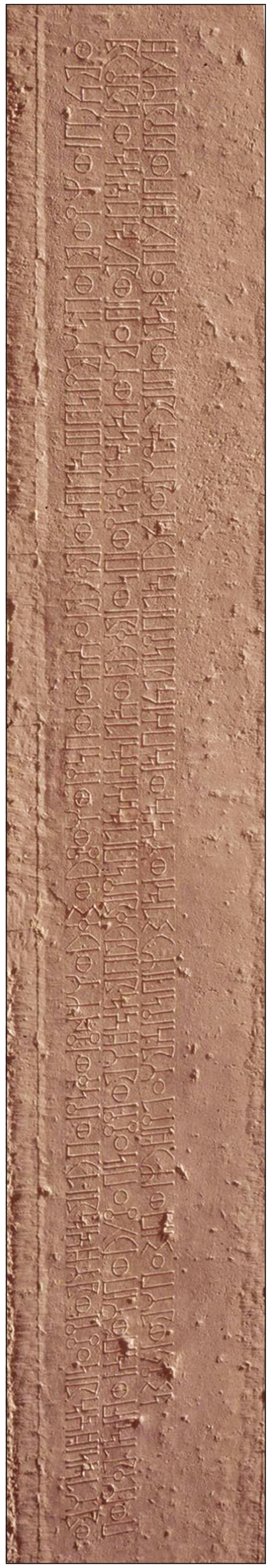


Figure 7: Inscription reports the construction of a Maʾḥaḏ-dam in the south oasis, Maʾrib (Photo: M. Maraqten)

4. Canalization and Canal Networks

Water supply canals, water distributors, secondary canals are an important part of water systems. Many terms are attested and pose a problem as to the exact meaning of some of them.

FNWT-Irrigation System

The term fnwt means “secondary canal” according to the Sabaic Dictionary (Beeston et al. 1982: 45) and is attested many times. A document on the construction of an irrigation system has been discovered in Wadi Ḍurā᾽ in ʿIryāb (ʿIryāb 1), near Umm Marjala in the same place of RES 3856 and to be dated to ca. 4th century BCE (Al-Baʿsī 2009:111-114, Fig. 9).

Transcription

1. ġlbm / ylhb / bn / dws[1]
2. m / bn / qs[3]mm / bny / ws[1]
3. ʿs[2]q / kl / mbr᾽ / wʿs[2]q
4. / fnwt / nḫls[1] / lhgn

Translation

1. Ġālibun Yalhub son of Dawsum
2. of the clan Qassāmum constructed
3. and completed the whole irrigation work and the construction
4. The distributary canal for the irrigation of his palm grove Lahgān.

5. Storage dams and reservoirs

Storage dams and reservoirs were constructed primarily in the highland of Yemen. Several studies and archaeological investigations on irrigation works have been carried out on the highlands of Yemen in the last two decades (Wilkinson 1999: 183–191, Lewis 2005: 81-106; Yule 2013: 31, 45ff). The epigraphic evidence illuminates several kinds of water tanks, cisterns and large reservoirs used for irrigation. Runoff water is collected from an adjacent catchment or channelled from a remote one and stored in cisterns (krf, pl. krwf, Yemeni Arabic karīf, pl. kirwaf), tanks (sg. brkt, birka) and reservoirs (m᾽gl). Cisterns are indigenous, surface reservoirs with capacity ranging from ten to one thousand cubic meters. Some had the function to store water for human and animal drinking. In many areas of Yemen, they are dug into the rock; in this case they usually have a small capacity. The most common of these storage reservoirs is m᾽gl (Yemeni Arabic mājil), which might be understood as a “large reservoir” (DhM 201, DhM 382, al-

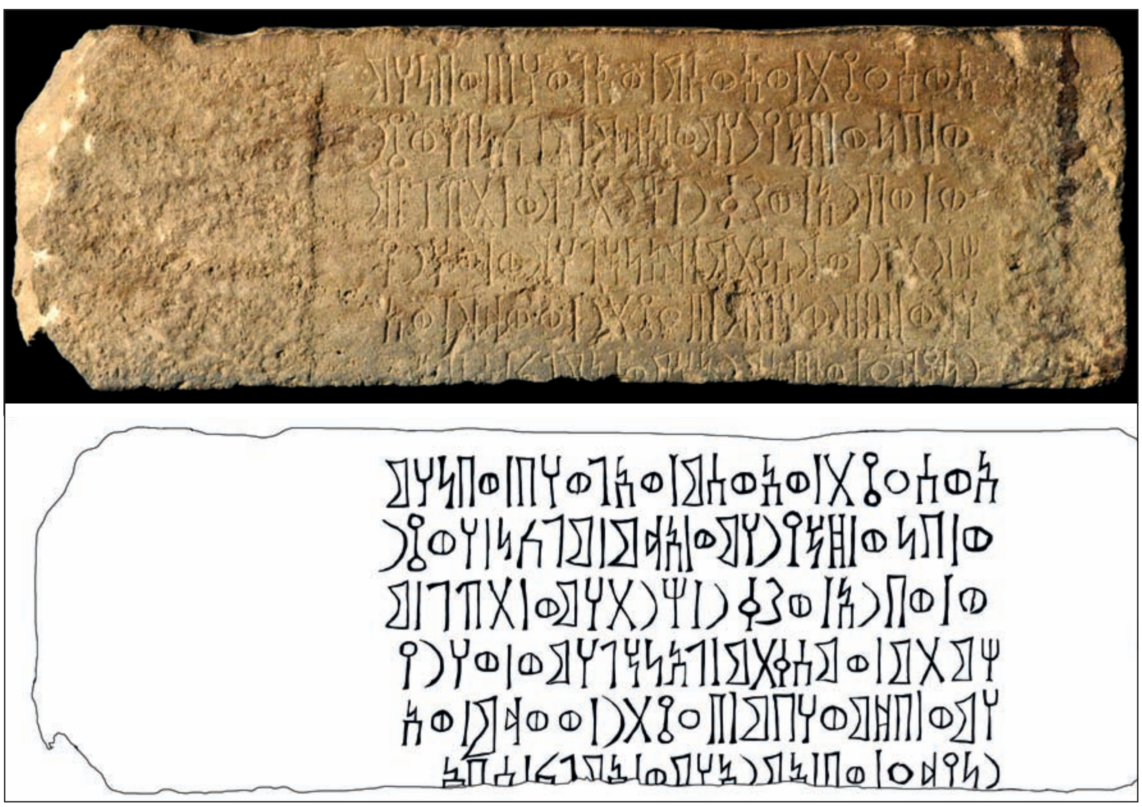


Figure 8: *A report on the construction of an irrigation system in wadi al-Jawf (Photo CSAI, 2009, facsimile M. Maraqten)*

Bārid 13; YM 1695, RES 4196, CIH 621).

B. Ground water irrigation systems

Although flood irrigation systems were common, ground water also found use. Two types are well documented in ancient South Arabian inscriptions: wells and the ghayl-irrigation systems.

1. Wells

Wells are artificial holes that reach the groundwater table. Many inscriptions mention that x hnbṭ bʾr-hw “x has dug to the groundwater his well” (e.g. MQ-Nakhlān 1/2, Sabaic, see also MṢM 146). Wells were used primarily to irrigate palm groves (Schiettecatte 2013).

2. Ghayl and Qanāt Irrigation

Although ghayl-irrigation systems are known in ancient and modern Yemen, little accurate investigation has been yet carried out on it (Varisco 1983: 365-383; Brunner & Kohler 1997: 176), vgl. Sabaic ġyl (pl. ʾġyl) “water-course; conduit, covered channel, ghayl” (Beeston et al. 1982: 54f.). It is primarily perennial “water-course” or a “spring flow” (Al-Selwi 1987: 166f.).

In this system water is stored in a reservoir and then distributed to the fields. The recent epigraphic discoveries (e.g. al-Jawf 04.37/10-13, al-Bārid 2010: 13) prove that this type of irrigation was widely spread more than scholars hitherto have supposed.

Recently several Sabaic and Minaic inscriptions have been discovered that provide us with data about the ghayl of Hirrān (ġyl hrn). This ghayl belonged to town of al-Bayḍāʾ (ns^2q) in the Yemeni Jawf (MAFRAY-al-Bayḍāʾ 100, MB 2005 I-44; cf. also Minaic YM 26106). The ghayl of Hirrān seems to have been a sacred space in the Minaean kingdom since it had the designation ġyl wd “ghayl of (the god) Wadd” in Minaean inscriptions (MṢM 116/4; Maʿīn 13/5; Maʿīn 1/6). No accurate studies on the ghayl-irrigation systems in ancient Yemen have been published. At the same time, several studies have been achieved on specific ghayls of the Islamic period such as those of Ṣanʿāʾ (Serjeant et al. 1983: 19-31; ʿAslān 2000) and Ghayl Bā Wazīr (Hehmeyer et al. 2002: 83–97).

The inscriptions inform us about the cutting of the bedrock to construct water reservoirs or canals such as in the southern sluice of the Ma’rib great dam (e.g. Schaloske 1995: 46-60, 92-96). A good example of the irrigation tunnels is the Baynūn water system (Müller 1973: 159f.; Wendrich et al. 1999). Two inscriptions document these constructions (Baynūn 1/2, Baynūn 2/3, Noman 2013: 77f.) [6].

The common thought is that the origin of qanāt-falaj system to be in Iran (Wilkinson 1977; Kuros & Khaneiki 2007). However, recent studies and archaeological investigation show that this irrigation system was developed earlier in Arabia (al-Tikriti 2011). Little is accurately known about

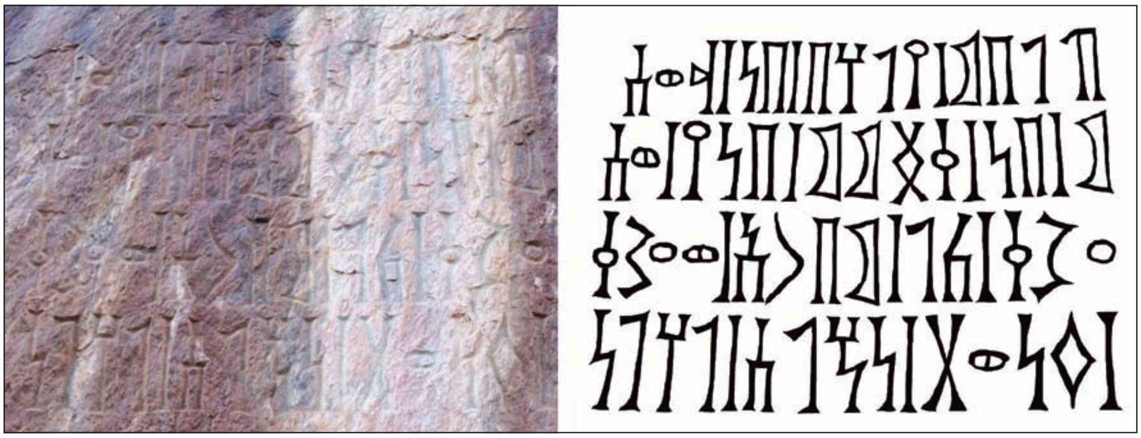


Figure 9: *Qatabanic rock inscription from wadi Ḍurāʾ (Photo: Al-Baʿsi 2009, facsimile: M. Maraqten)*

qanāt-falaj in Yemen in the pre-Islamic period and the idea of a Persian origin for the ghayls system in Yemen, which has been suggested by scholars (Serjeant et al. 1983: 25; Lightfoot 2000: 215-226; Brunner 2012: 181f.), needs more archaeological investigation. It is difficult to relate the ancient South Arabian ghayl-irrigation system to the qanāt-falaj system since we have no accurate archaeological or epigraphic evidence to support this thesis. It seems that the ghayl-system in pre-Islamic Yemen had a different technology other than the qanāt technology. Cutting canals in the bedrock is a local Sabaean technology in Ma'rib at least from the 6th century BCE onwards. According to the epigraphic evidence the ghayl-system existed in the Yemeni Jawf at least as early as the beginning of the 8th century BCE (Maʿīn 108, Arbach 2011). At the same time the system of the ghayls of the Islamic period in Yemen has been related to the qanāt-system taken until recently to be of Iranian origin (Serjeant et al. 1983: 25; Lightfoot 2000: 215-226) [9].

Dedication for the success of managing the irrigation system of ghayl-Hirrān in Wadi al-Jawf

This inscription (MB 2005 I-44, fig. 10) records an offering of Šaraḥʾīl who designates himself as vassal of the clan Kabīr Khalīl. The reason for the dedication was because Almaqah granted the success for Šaraḥʾīl to manage successfully the supervision period of water sharing of the ghayl of Hirrān, near the city of Našqum [10]. The text states that his overlord Wahablāt of the clan Kabīr of Khalīl ordered him to organize water sharing of the ghayl of Hirrān.

This inscription is engraved on a limestone pedestal with inscription of 16 lines of text. It was discovered at Awām temple/Maḥram Bilqīs during the excavations of the AFSM in 2005. It measures 31 x 44 x 11 cm and dates to ca. 3rd century CE.

Transcription

1. s^{2}rḥʾl [... ...]
2. ʾdm / kbr / ḫll / ... [/ hqny / ʾlmqhṯh]
3. wn / bʿl / ʾwm / ṣlmn / [ḏḏhbn] / ḥ
4. mdm / bḏt / hws^{2}ʿ / whwfyn / ʾlmqh
5. ʿbdhw / s^{2}rḥl / bs^{1}twfyn / qdmt / ġ
6. yln / hrn / bkn / wqh<h>w / mrʾhw / whb
7. lt / kbr / ḫll / lqtdmn / ġyln / hrn / b
8. hgrn / ns^{2}qm / wlḏt / ḫmr / ʾlmqh / ʿ
9. bdhw / s^{2}rḥʾl / frqn / wmtʿn / grbhw
10. bn / ʾmrḍ / mrḍ / bhyt / hgrn / ns^{2}qm
11. wḥmdm / bḏt / hṣḥ / whṣdqn / ʾl
12. mqh / ʿbdhw / s^{2}rḥʾl / bn / ḏmrn / s^{1}
13. wʾm / wl / wzʾ / ʾlmqh / ḫrynhw / bn / b
14. ʾs^{1}tm / wnḍʿ / ws^{2}ṣy / s^{2}nʾm / wl / s^{1}ʿdh
15. mw / ʾlmqh / ṯhwn / ḥẓy / wrḍw / ʾmr
16. ʾhmw / ʾkbrw / ḫll / bʿṯtr / wʾlmqh

Translation

1. Šaraḥʾīl […].
2. vassals of the clan Kabīr Ḫalīl. [dedicated to Almaqah Ṯah]wān
3. Lord of Awām the statuette of [bronze] in gratitude
4. because Almaqah helped and granted for
5. His servant Šaraḥʾīl to achieve the irrigation management of the ghayl
6. of Hirrān when his lord Wahablāt,
7. the Kabīr of Ḫalīl ordered him to command the irrigation office of the ghayl of Hirrān
8. in the town of Našqum. And because Almaqah granted
9. His servant Šaraḥʾīl the protection and safety of his person
10. from the illnesses he suffered in that town Našqum.
11. And in gratitude because Almaqah kept (him) in good health and duly Almaqah protected
12. His servant Šaraḥʾīl against bad affairs.
13. And may Almaqah continue to protect him
14. against misfortune and maleficence and the harm of any enemy
15. and may Almaqah Ṯahwān grant to them the favor and goodwill
16. of their overlords, the Kabīrs of (the clan) Ḫalīl. By ʿAṯtar and Almaqah.

III. Water rights and management

Ancient Yemenis determined and controlled the degree, amount, and timing of irrigation water in a planned and well-organized way. This goal is accomplished through consideration of the following aspects of an irrigation system such as irrigation scheduling, efficient transport of irrigation water, the use of runoff or tail water and management of drainage water. The significance of management of water ancient Yemen has been

noted by several scholars (Mazzini & Porter 2009: 283–294; Stein 2010b: 337–344; Maraqten 2013: 199-242) [11].

Several wooden stick texts illuminate water rights in ancient Yemen (ATHS 10, 11, 52, Maraqten 2014; TYA 11; X.BSB 121 = Mon.script.sab. 557, Stein 2010a). Texts documented on wooden sticks provide us with guidelines and rules for the distribution of water. Fortunately, certain terms relating to traditional irrigation have parallels in the inscriptions. These help us to clarify the legal terms and other issues concerning water rights in ancient Yemen. Especially in the field of water management law, ancient rules are preserved to this day and are still practiced (Maktari 1971; Varisco 1996: 238–57). The available data on water rights and management in ancient Yemen can be summarised as follows:

1. Ownership of the irrigation systems

Numerous property deeds of irrigation systems have survived (e.g. MṢM 3648, RES 3902 bis N° 130, DAI 1998-Wasserbau 1, HSM 1936.1.8), wells (MuB 524) cisterns (MuB 524). Documents regarding boundary stones which affirm the borders of irrigated land and estates have come to light (CIH 657, RES 3856, CIH 652). Several inscriptions mention that water systems were dedicated to specific deities or were placed under their protection (e.g. BynM 46, Ja 627, Ja 618, Maʿīn 108, RES 3856) to protect the irrigation system against flood destruction (e.g. Fa 71).

2. The irrigation management office

The head of the irrigation office could have been the Sabaean ruler himself. There were also special government organisations, such as an irrigation office which was responsible for the irrigation issues. Already by 8th century BCE an institution existed which was responsible for irrigation management issues (e.g. RES 4907, YM 18350, and see qdmt below). In some cases, central authorities such as the city senate regulated water rights for irrigation. The owner of the land needs to obtain from the office for irrigation an authorized certificate to use specific canals for irrigation water. This document grants irrigation rights (e.g. RES 4907, YM 18 352, CIH 611 = RES 852, MAFRAY-Huṣn Ā1 Ṣāliḥ 1). We have good data about legal documents in which farmers obtained irrigation rights to water palm groves, for instance in the town of ʿAraratum, Wadi Raghwān (e.g. RES 4907, YM 18350). Another document gives an authorization certificate regarding the distribution of water possibly in the Wadi al-Jawf, Yemen (ATHS 52).

3. Irrigation officials

In ancient Yemen several terms applied to irrigation officials "water inspector, master". Numerous terms denote the irrigation official in the traditional irrigation such as dāʾil (Al-Selwi 1987: 90), muqaddam al-miʿyān as in Ghayl Bā Wazīr (Hehmeyer 2005: 89).

QDM-Irrigation: The most common term used in the inscriptions to apply to the holder of a qdmt-office is a person called qdm (pl. ʾqdm) "foreman, master, supervisor, manager". One important responsibility of the QDM-irrigation manager seems to have been the allocation of water. The term qdmt, derives from the root QDM is frequently attested in Sabaean inscriptions as a designation for "irrigation management office" (TYA 11, MB 2005 I-44; X.BSB 121 = Mon.script. sab. 557; MAFRAY-al-Bayḍāʾ 100; CIH 365; YM 11099; DhM 208). The verbal forms qdm, tqdm and qtdm mean "be in charge of a job" (Beeston et al. 1982: 103).

MDRR-water inspector: The term mdrr/*mudarrir has been understood as "controller of irrigation" (Beeston et al. 1982: 36; Mazzini & Porter 2009: 289). The mdrr seems to have had a different function than the qdm. Apparently he was responsible for legal organization of the irrigation in the city council and was responsible to issue certificates for the right to use irrigation canals. This term is attested in several Sabaean inscriptions (YM 18352/8, Arbach & Audouin 2007: 84 no. 5; Gl 1563/8; Y.90.DA 2/7). Already in the 8th century BCE the Sabaean used a method to control the amount of water coming out of the valve to the canal, which was supervised by the mdrr-water master or inspector (e.g. MAFRAY-Ḥuṣn Āl Ṣāliḥ 1, Robin 1987: 165–177, Sabaic).

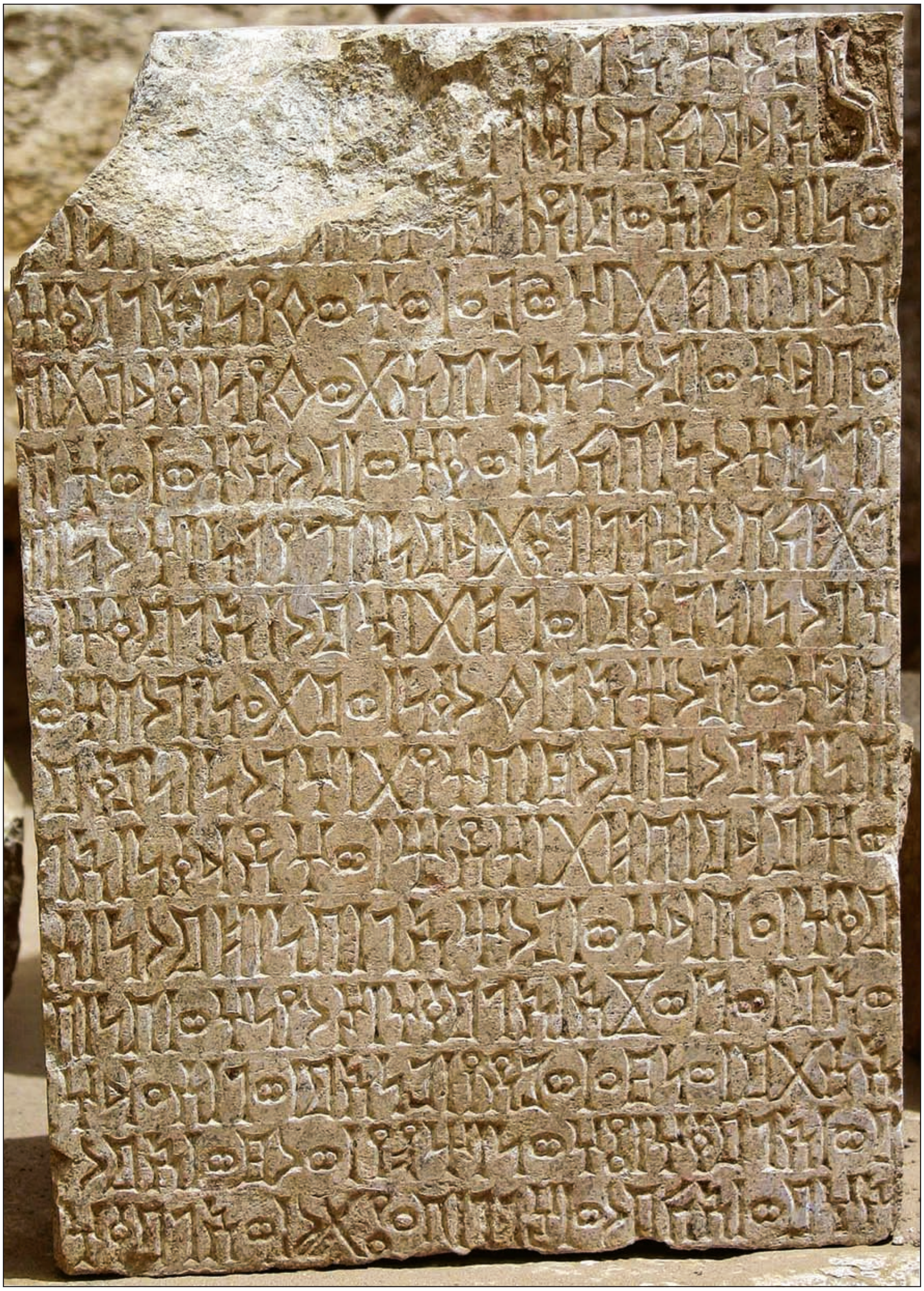


***Figure 10:** Dedication for the success of managing the irrigation system of ghayl-Hirrān in wadi al-Jawf (photo:AFSM)*

Kabīr of the irrigation: In the kingdom of Maʿīn an office for irrigation issues existed and the holder of this office was called kbr s¹qyt "Kabīr of the irrigation" (Haram 12 = RES 2743).

Kabīr of the ghayl-irrigation: We have a record on the work of the kabīr or water master of the ghayl-irrigation in Maʿīn (see kbr ġyln in Maʿīn 108, Arbach 2011: 209-210, figs 11-12).

4. The Sabaean water clock and water allocation

There were special legal rules for allocation of water for irrigation. We have several texts that give us data about provisions for water distribution (e.g. CIH 611; MAFRAY-Ḥuṣn Āl Ṣāliḥ 1, Robin 1987: 167-169) and time-measurement for irrigation. Ancient Yemenis used the term mfrʿ (pl. mfrʿt) to measure the time allowed for irrigation. This Sabaean water clock was used by the water master of the ghayl (qdm, kbr). The Sabaic term mfrʿ seems to have been the accurate designation for specific "water unit or water measure of the amount of water" that served for the water allocation during a specific irrigation period. Several minuscule documents have come to light recently that relate to the water allocation using the system of mfrʿ and in particular in relation of the ghayl-Hirrān as it is attested in a Sabaic letter to the water masters of this ghayl (X.BSB 121 = Mon.script.sab. 557, Stein 2010a). This term occurs also in a recently published text on water rights in the Yemeni Jawf (ATHS 10, Maraqten 2014: 191-197).

The Sabaic term mfrʿ, Yemeni Arabic mafraʿ continued in use in Yemen in the Islamic Period even until recent times for the allocation of the ghayls around Ṣanʿāʾ (ʿAslān 2000: 55-58) [12]. It seems that the Sabaic mfrʿ had the function of the ṭāsa. The time for irrigation divides the daytime and night to 120 mafraʿ as it was used in Ṣanʿāʾ in recent times (ʿAslān 2000: 55f.). The ṭāsa is a small pot full of water with a small hole in the bottom. The ṭāsa is an outflowing water clock. It was filled with water, which was allowed to leak out. The irrigation time is counted by the number of the filled ṭāsa (Maraqten 2014: 195f.).

Conclusion

In the light of the epigraphic evidence, this paper provides an overview of ancient water harvesting techniques which were applied in ancient Yemen. This paper is a summary of a major study on this topic. This new approach proves that using the whole written record related to irrigation structures and considering the whole history of these structures in all parts of the land changes our knowledge about the irrigation systems in ancient Yemen. For instance, considering some examples of the epigraphic evidence in this study, we have new insights about the socio-economic structure of the ancient South Arabian society such as the recently discovered epigraphic evidence at the Awām temple relating to the water management of the ghayl of Hirrān. There

were specific Sabaean clans such as the Kabīr Khalīl, Banū Ḥulūlum, Banū ʿUṯkulān who owned many of the irrigation works and the irrigated land estates in Ma'rib and Wadi Raghwān as well as in Wadi al-Jawf. These clans were also responsible for the water management of the ghayl of Hirrān, the most important perennial watercourse in Wadi al-Jawf. The inscriptions show that the ancient Yemenis made a detailed documentation of one most important sector of their economy and the base of their culture. The data engraved on wood give us new data on the allocation of water and prove that the ghayl-irrigation system was used more than it has been suspected.

Abbreviations

AAE = Arabian Archaeology and Epigraphy
ABADY = Archäologische Berichte aus dem Yemen, Philipp von Zabern: Mainz am Rhein.
ATHS = Maraqten 2014
BynM = Baynūn Museum, see Prioletta 2013 and CSAI
CSAI = Corpus of South Arabian Inscriptions, University of Pisa, http://www.csai.humnet.unipi.it
DhM = Dhamār Museum, see Prioletta 2013 and CSAI
CIH = Corpus inscriptionum semiticarum IV. 1889-1932.
HSM = Harvard Semitic Museum, see CSAI
Ja = A. Jamme, 1955, 1962
MB = Maḥram Bilqīs
MṢM = Military Ṣanʿāʾ Museum, CSAI
PSAS = Proceedings of the Seminar for Arabian Studies. London.
RES = Répertoire d'Epigraphie Sémitique, Paris 1914-.
TYA = Ryckmans et. Al. 1994
YM = Yemen Museum

On further sigla and abbreviations see Kitchen 2000 and CSAI.

Footnotes:

1. Several dams mentioned in the inscriptions appear in the Yemen map, see Robin & Brunner 1997.

2. On the Archaeological discoveries which have been primarily carried out by the German Archaeological Institute (DAI), the French Archaeological Mission in the Republic of Yemen, the Italian Archaeological Mission in the Republic of Yemen and the American Foundation for the Study of Man (AFSM), the University of Chicago and the University of Heidelberg, see Archäologische Berichte aus dem Yemen vols. I-VII; Brunner 2003; Hehmeyer & Schmidt 1991; Schaloske 1995; Vogt 2004; Mouton 2004: 81-104; Wilkinson 1999: 183–19; Wilkinson 2003: 186-189; Lewis 2005: 81-106; Charbonnier 2009: 81-94; Charbonnier & Schiettecatte 2013: 69–89; Darles et al. 2013: 7-68; Robin & Dridi 2004: 67-121; Robin 2013: 247-287 and Yule 2013: 31-32.

3. The dissertation of A.K. Irvine (1962) on irrigation terms is now out of date. Recently a good collection of the inscriptions relating to irrigation has been gathered in a M.A. thesis submitted to University of Hassan II in Casablanca (Al-Bārid 2010).

4. See the discussion in Brunner & Kohler 1997: 171-174; Brunner 2012: 195f.

5. On the date of the construction of the great dam of Mårib, see Francaviglia 2000: 645–653 and Vogt 2004: 383-394.

6. These inscriptions will be published by the author.

7. On palm groves in ancient Yemen see Schiettecatte 2013: 2-20.

8. See Beeston et al. 1982: 109.

9. See also the discussion in Hehmeyer et al. 2002: 94f.

10. On the ġayl of Hirrān, see von Wissmann 1964: 253, 347.

11. On the allocation of water in the traditional irrigation in Yemen, see ʿAslān 2000 and Hehmeyer 2005: 87–96.

12. Al-Hamdānī, Ṣifa, 104 mentions that Muṭarrif b. Māzin was al-muḫtriʿ li-mafāriʿ l-ġuyūl "the inventor of the mafraʿ-system of the ghayls". On this function of mafraʿ, see Maraqten 2014: 195f.

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PREFACE

Abu Dhabi Tourism & Culture Authority encourages research and disseminates publications on the archaeology of the United Arab Emirates. Of particular interest is the history of water use and technology in these regions. Unlike Egypt, Mesopotamia and the Indus Valley, Arabia has no permanent rivers and, for most of the peninsula, very little rainfall. This resulted in innovative technologies that were used to access groundwater or run off from mountains.

A conference was organised by the Abu Dhabi Tourism & Culture Authority in December 2014 with a view to exploring these technologies and their social context. Archaeology and hydrology specialists, were brought together to present their research in the Arabian Peninsula. Arabic speakers from the UAE, Kuwait, Bahrain, Saudi Arabia, Oman, together with speakers from Germany, France and Canada gathered in Al Ain (Qattara Art Centre) in December 2014 and submitted their findings.

The wide range of papers presented and incorporated in this volume, address several important topics. These include ancient agricultural landscapes; the history of aflāj in the Eastern Region of Abu Dhabi Emirate; and ancient and historical irrigation systems in Yemen and Oman. Another case study from Abu Dhabi Emirate explored issues of sustainability through water resource diversification in Al Ain. Five additional papers in Arabic discuss irrigation systems in Saudi Arabia; water resources in the ancient and Islamic periods in Bahrain; ancient wells in northwest Kuwait; the Abbasid water systems in Al Ain; and historical aflāj in Al Ain.

These papers represent an important attempt to enhance research and our understanding of water history in Arabia. Several subjects emerged as worthy of more research and attention. One such theme is the origin and dispersal of aflāj. Currently our evidence suggests that this fascinating technology originated in the UAE and Oman, before dispersing to the rest of the Middle East, China, and North Africa. Further research on this issue will do much to illuminate the fascinating history of water use in Arabia and the critical role that the UAE played in this history.

Mohamed Khalifa Al Mubarak
Chairman of Abu Dhabi Tourism and Culture Authority

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